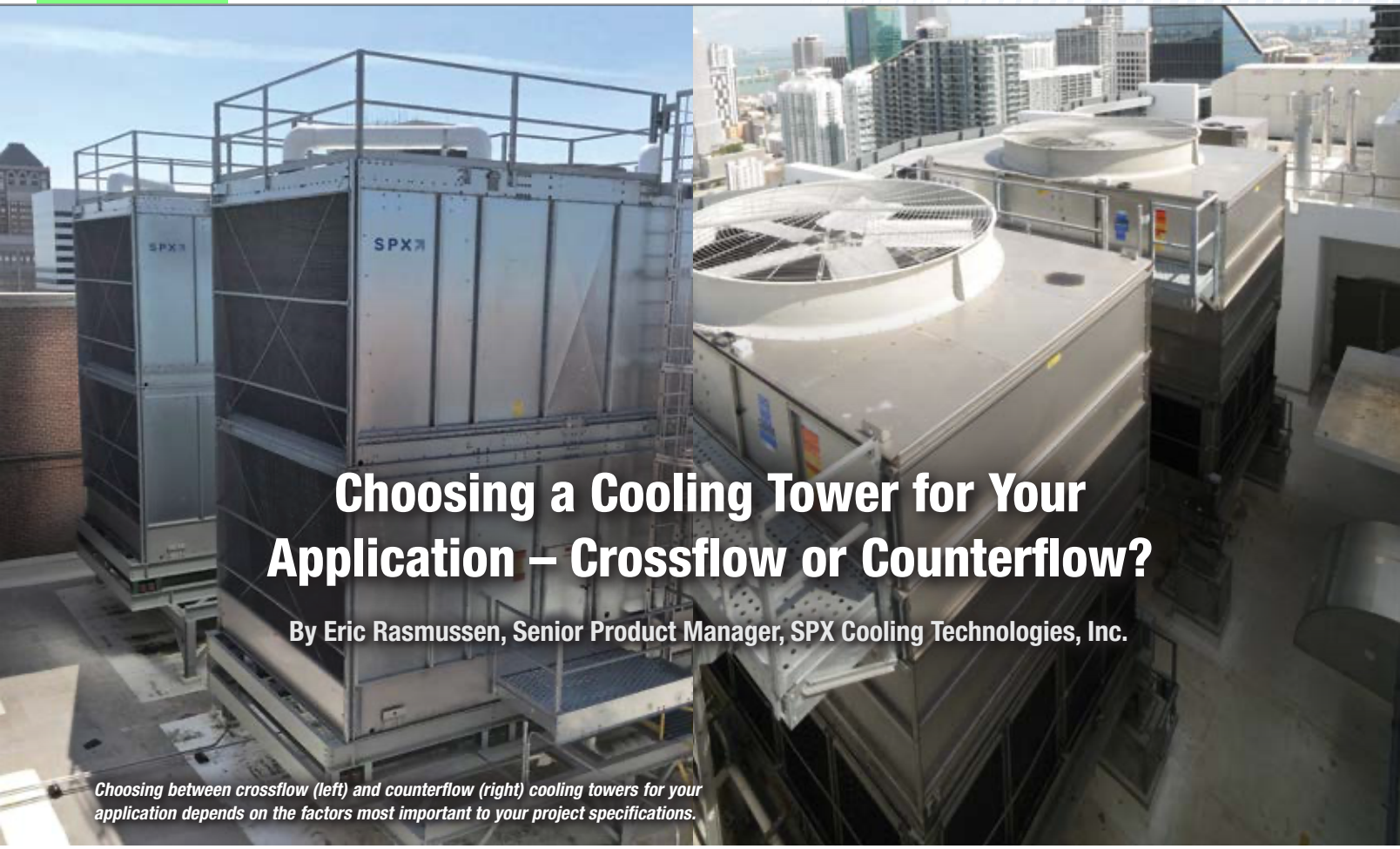


Choosing a Cooling Tower for Your Application – Crossflow or Counterflow?

By Eric Rasmussen, Senior Product Manager, SPX Cooling Technologies, Inc.

Choosing between crossflow (left) and counterflow (right) cooling towers for your application depends on the factors most important to your project specifications.

➤ With efficient heat exchange an important requirement in the design of an HVAC system, the type of cooling tower you specify to support your project's unique cooling goals requires careful consideration. After determining the process parameters required for your application – tonnage, range, and approach – cooling tower capabilities can be analyzed.

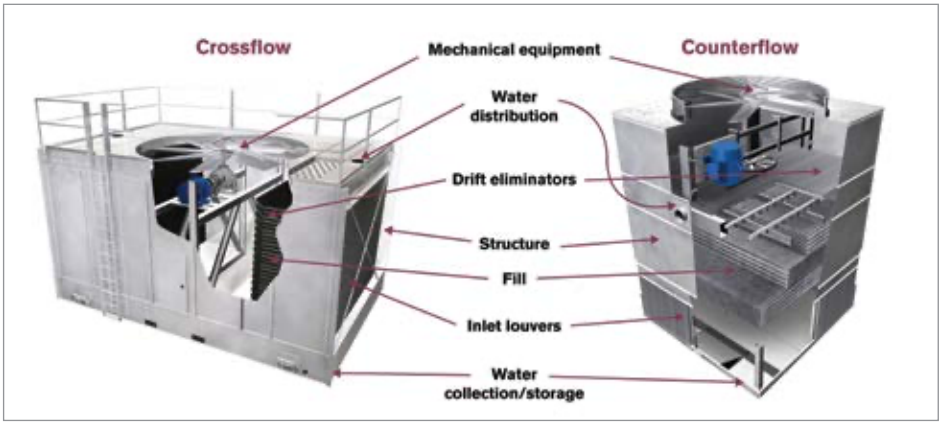
Because induced draft crossflow and counterflow cooling towers both have distinct advantages, the design requirements and conditions specific to your application determine the appropriate cooling tower for your project. The fundamental difference between crossflow and counterflow cooling towers is how the air moving through the tower interacts with the process water being cooled. In a crossflow tower, air travels horizontally across the direction of the falling water. In a counterflow tower, air travels vertically upwards in the opposite direction (counter) to the direction of the falling water.

Physical Size – Footprint

Every cooling tower requires a certain volume of air to effectively exchange the heat in the process water. Thus, a cooling tower's plan area and height must be considered with your specific application in mind.

At cooling capacities up to about 750 tons (3295kW), a counterflow cooling tower with its vertically-stacked components may require less plan area than a crossflow cooling tower. Beyond the 750 ton mark, because crossflow tower modules are stacked vertically at higher tonnages, a counterflow tower offers little to no advantage in footprint versus a crossflow tower and can sometimes take up more plan area.

Depending on the application, a crossflow cooling tower may require less total area than a counterflow tower even at heat loads less



While structural and mechanical components of crossflow and counterflow cooling towers are similar, application-specific design requirements should determine the tower type.

than 750 tons because of the location and number of air inlets – a crossflow tower has two air inlets compared to four air inlets on a counterflow tower.

Maintenance

Routine maintenance is essential to extend the life of a cooling tower so maintenance accessibility is a consideration. The method by which air interacts with the process water in each tower type creates two different styles of plenum areas. This space has a direct effect on maintenance accessibility.

In crossflow cooling towers, the air flow is turned from the horizontal air inlet direction to the vertical discharge direction behind the fill media. This creates a tall, easily accessible plenum inside the tower for inspection and servicing of the cold water basin, drift eliminators, motor, drive system, and fan at the top of the cooling tower.

Counterflow cooling towers turn the air from horizontal to vertical flow beneath the fill media. While this gives good access to the cold water basin, the rest of the tower is more compact with lower overall height. This creates limited access to the spray system, eliminators, motor, drive system, and fan.

Operating Weight

The overall shipping and operating weights of a crossflow cooling tower may be heavier than a counterflow tower due to the crossflow tower's larger footprint, additional structural supports and steel casing for ease of maintenance access and additional piping for water distribution. However, lighter capacity cranes are typically required to hoist individual modules, which are stacked vertically at higher tonnages. Potential crane and logistical savings must be weighed against the need for additional picks per cell.

Gravity-Fed and Pressurized Water Distribution

A significant design difference between a crossflow and counterflow cooling tower is the method by which water is distributed over the fill media.

In a crossflow cooling tower the process water is pumped to the top of the tower into the hot water distribution basin. The distribution basin is out of the way of the airstream and is gravity fed. The only driving force behind the nozzles is the hydrostatic head of water above the nozzle itself. One advantage of gravity-fed crossflow water distribution is that it can be cleaned while in operation since it is easily accessible from the outside top of the cooling tower.

In a counterflow cooling tower, process water is pumped into a sealed header box. The header box then distributes the water into branch arms and nozzles, creating a pressurized water distribution system. Unlike a gravity-fed system, a counterflow tower's water distribution system requires pumps to be shut off to clean the nozzles and the cold water basin. To inspect and clean nozzles, one must enter a crawl space inside the tower.

Variable Flow and Cold-Weather Operation

There are significant energy savings opportunities if a cooling tower can be operated under variable flow conditions. When the conditions allow (reduced heat load or cool ambient conditions), reducing

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the flow rate over the cooling tower instead of the process keeps the process operating in its most efficient manner. Variable flow, or "turndown," is a way to maximize the effectiveness of the installed cooling tower capacity for any process flow.

Crossflow cooling towers with outboard water inlets and integral inlet louvers handle very high turndown rates (up to 70% or more). Counterflow cooling tower distribution systems are not as easily modified; up to 50% turndown may be achieved but additional pump head may be required.

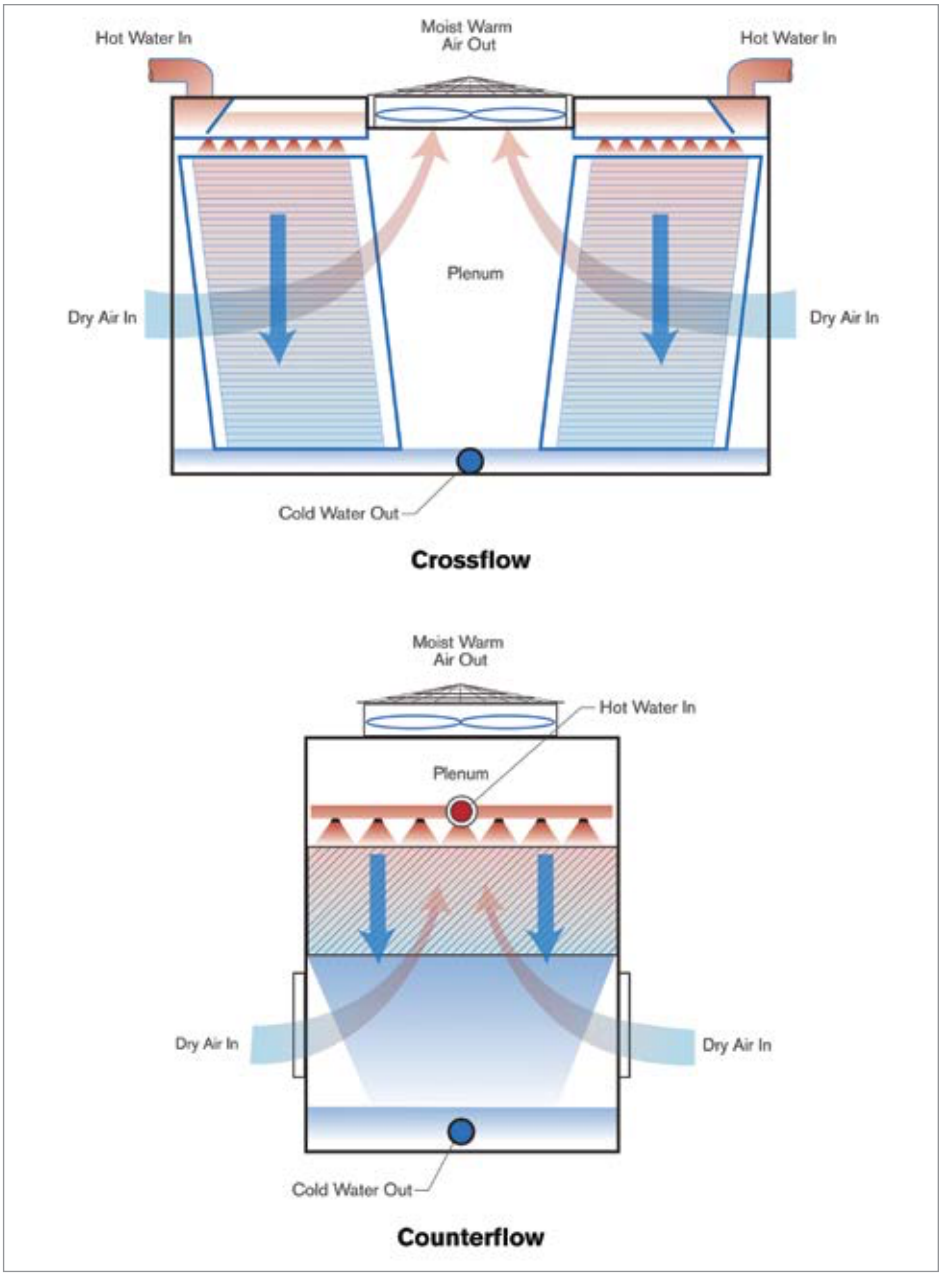
Cold-weather operation is of paramount importance when choosing a cooling tower to operate in sub-freezing conditions. Ice formation is an ever present danger and can damage tower components including the high efficiency heat transfer fill media. The effects of ice damage can result in higher condenser water return temperatures and increased chiller energy consumption during peak cooling season.

A crossflow cooling tower performs especially well in cold weather. With its gravity-fed water distribution system – even with turndown as low as 30% of design flow – water can still be evenly distributed across the fill. Even distribution prevents water channeling, ice development, unpredictable performance, scale buildup, and potential damage to the tower. During cold-weather operation, the use of devices such as cups or dams in the hot water basin can keep the heat load toward the weather exposed face of the fill, alleviating ice buildup.

At low-flow operation, a counterflow cooling tower has less head pressure and fewer nozzles to distribute water across the entire cross-section of the fill allowing for uneven distribution. Uneven distribution leads to water channeling, ice development, unpredictable performance, scale buildup, and potential damage to the tower.

Minimum flow rates are both tower type and model specific. Be sure the cooling tower manufacturer understands the minimum anticipated flow rate and confirm the tower can handle the required hydraulic range.

Louvers are designed to keep water within a cooling tower. They prevent splash out



The fundamental difference between crossflow and counterflow cooling towers is how the air moving through the cooling tower interacts with the process water being cooled. Air travels horizontally across the direction of the falling water in a crossflow tower. In a counterflow tower air travels vertically upwards in the opposite direction (counter) to the falling water.

which can turn to ice in sub-freezing ambient conditions. Integral louvers incorporated into the fill of some crossflow towers help keep water contained in the fill. This provides no external surface for ice development to occur. Counterflow tower louvers are separate from the fill near the cold water basin. The turbulent water splashing in the cold-water basin can lead to ice accumulation on the louver faces during freezing weather.

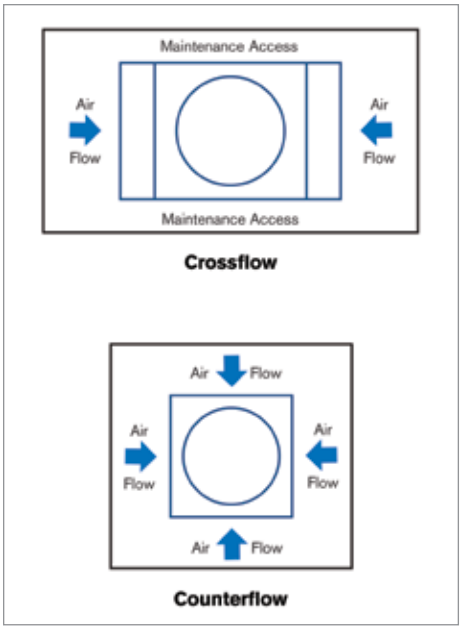
Heat Transfer Fill

Both counterflow and crossflow fills can vary in shape and size. The appropriate fill for your cooling tower should be based primarily on water chemistry. Suspended solids, biological growth potential, and information about constituents in the process water that can lead to scaling must be determined early in the design process.

Balancing the performance required by a specific fill material and the water chemistry of the process water are the significant factors in choosing the right fill and type of cooling tower for your project. The best fill type for your application, either film fill or splash fill, depends on biological growth potential and the level of suspended solids in your source water. Cooling tower manufacturers publish guidelines that can be used to help determine the quality of your process water source.

High-efficiency PVC film fill is typically used in cooling towers with clean water. This fill is manufactured in cross-corrugated sheets that stretch the falling water into a thin film on the surface of the PVC sheet. The water then interacts with the airflow through the tower to facilitate the heat transfer. Because more surface area for air-to-water contact is

CROSSFLOW AND COUNTERFLOW COOLING TOWER DISTINCTIONS
CROSSFLOW ADVANTAGES
Capable of up to 70% turndown
Performs well in cold-weather applications
Water distribution system can be cleaned while tower is in operation
More access for routine maintenance
Uses high efficiency heat transfer fill
COUNTERFLOW ADVANTAGES
Smaller footprint up to ~750 tonnage (with film fill)
Potentially lower operating weight
May be easier to install
Accommodates wide range of fill types to address source water quality



Depending on the application, a crossflow cooling tower may require less total area than a counterflow tower because of the location and number of air inlets; a crossflow tower has two air inlets compared to a counterflow tower's four air inlets.

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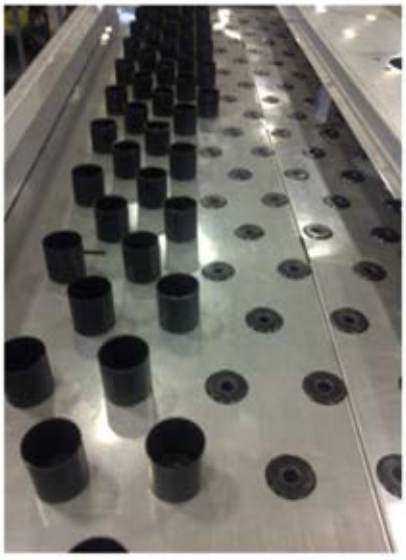
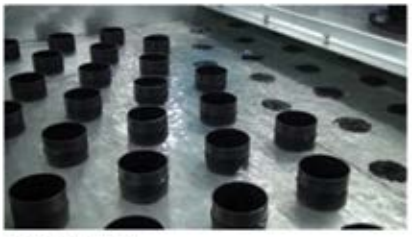
A crossflow cooling tower's large plenum area allows easy maintenance.

A counterflow cooling tower's stacked components are less accessible for service.



Full Flow



Reduced Flow

Variable Flow Cups – when operating a crossflow cooling tower in cold weather, devices such as cups or dams in the hot water basin keep the heat load toward the side of the fill exposed to the elements.

available, film fill types are more efficient than splash fills.

Film fill is not appropriate for all applications due to its higher propensity for clogging and fouling. Splash fill is more tolerant of dirty water sources but has lower thermal efficiency that requires a larger structure. This often makes it more costly than film fill type towers for a given load.

Clog-resistant film fill provides a happy medium between the efficacy of high-efficiency film fill and splash fill in both thermal performance and clog resistance.

Summary

Choosing between a crossflow and counterflow cooling tower for your application depends on the factors most important to your project specifications. Both types are effective means to support chillers and achieve efficient evaporative cooling with a few distinct design differences. BP

Eric Rasmussen is a senior product manager and licensed engineer at SPX Cooling Technologies, Inc., Overland Park, KS.

SPX Cooling Technologies, Inc. is a leading global manufacturer of cooling towers, evaporative fluid coolers, evaporative condensers, industrial evaporators and air-cooled heat exchangers providing cooling solutions, components and technical support for heating, ventilation and air conditioning (HVAC), refrigeration, and industrial process cooling applications for nearly a century. SPX Cooling Technologies and its product brands are part of SPX Corporation. For more information visit www.spxcooling.com

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